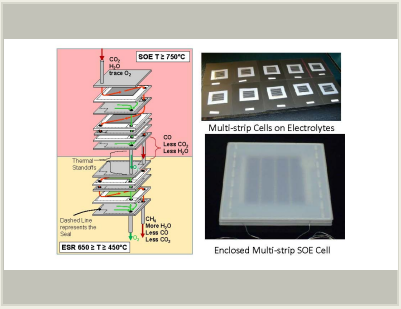
Small Business Innovation Research/Small Business Tech Transfer

Highly Efficient Solid Oxide Electrolyzer & Sabatier System, Phase II

Completed Technology Project (2014 - 2017)

Project Introduction

Paragon Space Development Corporation (Paragon) and ENrG Incorporated (ENrG) are teaming to provide a highly efficient reactor for carbon monoxide/carbon dioxide (CO/CO2) conversion into methane (CH4). The system is a gravity-independent, compact, leak-tight, Solid Oxide Electrolyzer (SOE) system with embedded Sabatier reactors (ESR). Applying Corning Incorporated (Corning) Intellectual Property (IP), ENrG and Paragon can leverage an all-ceramic, efficient, and low mass solid oxide fuel cell (SOFC) that remains leak-tight after hundreds of thermal cycles. Paragon proposes that incorporation of the all-ceramic technology into our SOE/ESR system will result in a design that will: 1) be thermally shock tolerant and capable of hundreds of on-off cycles at faster cycles than compared to the metal-to-ceramic SOE designs, 2) be lighter, smaller, and require less power than existing designs, 3) allow for high (>90%) single pass utilization of feedstock, and 4) achieve a thermodynamic efficiency of up to 80%. Our Phase II effort includes laboratory tests to optimize operation of an all-ceramic design for increased single pass utilization of the feed stock and mitigation of carbon deposition. Engineering analyses and component testing will be performed to inform the design of a stack. The stack will be built and tested to verify requirements. Results will be used to size a full system with recommendations for integration. An engineering development unit will be built and delivered to NASA. Integrating cells that operate as either an electrolyzer or a Sabatier reactor simplifies operations, lowers hardware complexity, and increases reliability. The proposed system can perform multiple functions without modifications, making it a readily deployable technology for various missions from ISRU on the Moon and Mars to regenerating 100% of a crew's oxygen in spacecraft or habitats.



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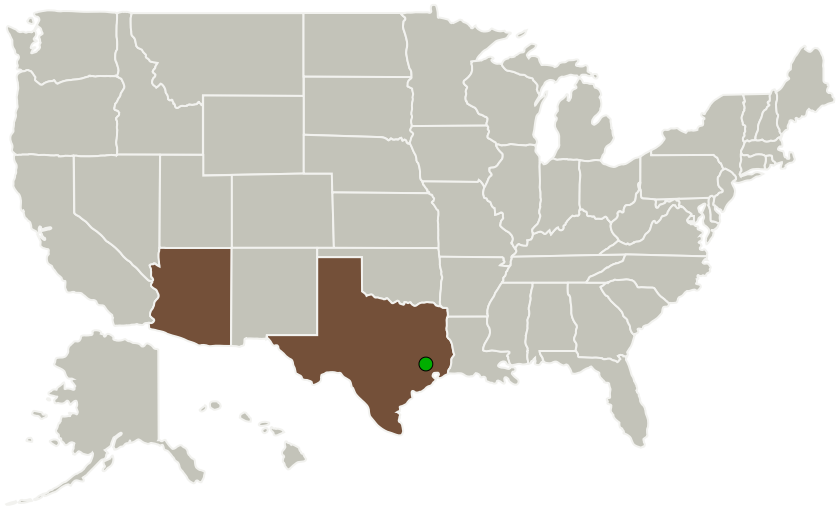
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Paragon Space Development Corporation	Lead Organization	Industry	Tucson, Arizona
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas

Primary U.S. Work Locations	
Arizona	Texas

Project Transitions

April 2014: Project Start

January 2017: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137450)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Paragon Space Development Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Thomas J Cognata

Co-Investigator:

Thomas J Cognata

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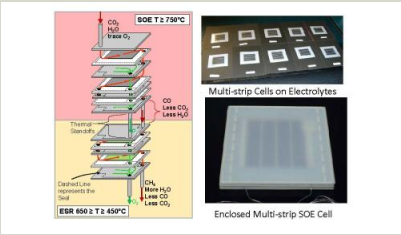
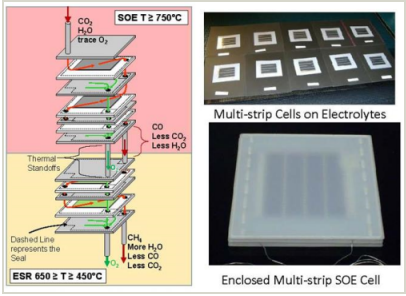
Images



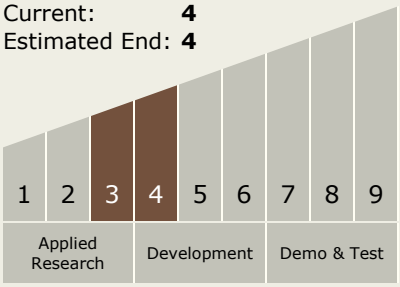
Briefing Chart Image
Highly Efficient Solid Oxide Electrolyzer & Sabatier System, Phase II
(https://techport.nasa.gov/image/130241)



Final Summary Chart Image
Highly Efficient Solid Oxide Electrolyzer & Sabatier System, Phase II Project Image
(https://techport.nasa.gov/image/127286)

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.1 In-Situ Resource Utilization
    - TX07.1.3 Resource Processing for Production of Mission Consumables

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System